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CARBONISATION OF MARKING NUT SHELL (*SEMECARPUS ANACARDIUM*)

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ABSTRACT

The proximate and ultimate analysis of marking nut shell, deoiled shell and traditionally deoiled shell was carried out by using muffle furnace. The proximate analysis viz. moisture content, volatile matter, ash content and fixed carbon content and also ultimate analysis viz. carbon, hydrogen, nitrogen and oxygen content of various samples were analysed. Moisture content of the MNS was 2.484 % and for MN deoiled shell and traditionally deoiled shell was found to be zero percent. The volatile matter present in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 85.093%, 54.521% and 81.737% respectively. Ash content in the MNS, marking nut deoiled shell and marking nut traditional deoiled sample was found to be 4.35%, 34.82% and 10.89% respectively. The fixed carbon percentage in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 8.074%, 10.64% and 7.37% respectively.

KEYWORDS: Marking Nut Shell, Deoiled Shell

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INTRODUCTION

The Scientific name of marking nut is *Semecarpus anacardium* L belonging to the family *Anacardiaceae*. It is known as bhallatak or Bhilwa in India and also called “marking nut” by Europeans, because it was used by washermen to mark cloth and clothing before washing, as it imparted a water insoluble mark to the cloth. It is also known as kerbeeja in Kannada and bibba in Marathi. Marking nut is very important fruit in concern with its utilization in ayurvedic medicines and industries. In Maharashtra production of marking nut is about 1600 tons/year, in Madhya Pradesh, Andhra Pradesh and Orissa it is about 700 tons (Kubade and Phirake, 1990). It is a rich source of phenols, biflavonoids, phenolic compounds, bhilawanols, minerals, vitamins and amino acids, which show various medicinal properties. Traditionally, marking nut used for marking lines, manufacture of varnishes lacquers, enamels and paints. It is also used for water proofing textile fabrics, imparting lather finish to cloth, paper boards and card boards, in production of insecticides, antiseptics, termite repellents and moth proofing agents, in synthetic detergents, herbicides and fire proofing plastics. Also it can be used to cure esophagus and mouth cancer, leprosy and sciatica, against the bacterial infections etc. (Majumdar et al 2008).

REVIEW OF LITERATURE

Ganesh and Das (2003) studied for the product distribution in a packed bed vacuum pyrolysis unit of cashew nut shell (CNS). The proximate and ultimate analysis of cashew nut shell and CN deoiled shell were determined. The moisture content found as 10.43%. The volatile matter found as 69.31 and 58.00% for cashew nut shell and doiled shell.

Sanger et al (2011) reported that cashew nut shell (CNS) was utilized for carbonization in developed prototype kiln. Prototype kiln was evaluated with direct and indirect methods and characteristics of CNS and CNS char were determined by proximate and ultimate analysis. The maximum CNS temperatures obtained inside the kiln during direct and indirect method was recorded as 452.2^{0}C and 458.8^{0}C respectively. Maximum oil percentage, charcoal percentage and ash percentage in direct method were observed as 21.1 %,21.04 % and 3.34 %respectively whereas 23.8 %, 18.3 %and 1.27 %in indirect method respectively. Hydrogen content in CNS was found about 6 to 7 %and nitrogen content in CNS was found about 0.70 to 0.75 %. Oxygen content in CNS was observed about 29 to31 %. Carbon, hydrogen and nitrogen content of the CNS char were observed in the range of 73 to76 %, 4 to 5 % and 1 to 2 %respectively. It was found that nitrogen content has increased in CNS char after the carbonization of CNS. Oxygen content in the CNS char gets reduced to13 to 14 %, which was comparatively very less than CNS. It was observed that indirect method is more suitable for carbonization than direct method for obtaining higher calorific value char and maximum fixed carbon percentage as found in cashew nut shell char as 60 per cent.

Akpabio (2012) studied the proximate composition, mineral elements, anti-nutrients (toxicants) and lipid characteristics were determined for almond (Terminalia catappa) seeds. The results obtained showed the proximate composition of 25.23% moisture; 5.00% ash; 32.73% lipid; 33.66% crude fibre; 3.11% crude protein; 25.47% carbohydrate and caloric value 534.200 kcal. Mineral elements determined were P, Na, K, Fe, Mg and Ca, while the anti-nutrients evaluated were hydrogen cyanide, oxalate and tannin. Almond seed oil was also characterized.

Francis (2012) reported that this work is on the possibility of producing bio-lubricant with soybean seeds as a case study. Solvent extraction process using normal hexane was used. Proximate properties such as moisture, volatile matter, ash, fixed carbon content. The percentages of the moisture, volatile matter, ash, and fixed carbon content in the soybean seed are 7.95, 72.27, 6.08 and 13.70%.

MATERIAL AND METHODS

The marking nut shell was selected as a major raw material for the carbonization process. The carbonization of marking nut shell was carried out in muffle furnace. The shell was utilized for conducting experimentation at Department of Agricultural Process Engineering, Dr. PDKV and Akola. The proximate and ultimate analysis of marking nut shell was carried out to find out the fuel properties.

Determination of Crude Oil in Marking Nut Shell by Soxhlet Method

The crude oil was determined using Soxhlet apparatus by adopting the method suggested by Thimmaiah, (1999).

Weight 2-3 g of dried marking nut shell sample in a thimble (prepared from **whatman** No.1 filter paper) and place it in a Soxhlet apparatus. Connect a dry pre-weighted solvent flask (‘a’, g) beneath the apparatus and the required volume of solvent (Petroleum ether, b.p. 60-80 ^{0}C or ethyl ether or hexane) and connect to condenser. Adjust the heating rate to give a condensation rate of 2-3 drops and extract for 16 h. Remove the thimble and retain ether from the apparatus. Evaporate the excess ether from the solvent flask on a hot water bath and dry the flask at 105 ^{0}C for 30 min. Cool the flask in desiccators and weigh (‘b’, g)

$$\text{Crude oil content (\%)} = \frac{(b-a)}{\text{Weight of sample (g)}} \times 100 \qquad 1$$

Determination of Proximate and Ultimate Analysis of Marking Nut Shell (MNS)

The proximate and ultimate analysis of marking nut shell was carried out by using muffle furnace.

Proximate Analysis of Marking Nut Shell (MNS)

The moisture content, volatile matter, ash content and fixed carbon content of marking nut shell were calculated under the proximate analysis.

Determination of Moisture Content

About 1g of finely powdered air-dried sample was weighed in a crucible. The crucible was placed inside an electric hot air-oven, maintained at 105-110 ^{0}C. The crucible was allowed to remain in oven for 1 hour and then taken out (with the help of a pair of tongs), cooled in desiccators and weighed. Loss in weight was reported as moisture content (on percentage basis) (Jain and Jain, 2001).

$$\text{Percentage of moisture } (\%\ \text{w.b}) = \frac{\text{loss in weight}}{\text{weight of sample taken}} \times 100 \qquad 2$$

Determination of Volatile Matter

Volatile matter was determined by keeping the dried sample of marking nut shell left in a crucible is then covered with a lid an place in an electric furnace (muffle furnace) maintained at 925 ± 20 ^{0}C the crucible is taken out of the oven after 7 minutes of heating. The crucible is cooled first in air, then inside a dessicator and weighed again. Loss in weight was reported as volatile matter on percentage basis (Jain and Jain, 2001).

$$\text{Percentage of volatile matter} = \frac{\text{loss in weight due to remove in volatile matter}}{\text{weight of sample taken}} \times 100 \qquad 3$$

Determination of Ash Content

The residual sample in the crucible was then heated without lid in a muffle furnace at 750 ^{0}C for half an hour (ASTMD- 3174). The crucible was then taken out, cooled first in air, then kept in desiccators and weighed. Heating, cooling and weighing was repeated, till a constant weight was obtained. The residue was reported as ash on percentage-basis (Jain and Jain, 2001).

$$\text{Percentage of ash} = \frac{\text{Wt. of ash left}}{\text{weight of sample taken}} \times 100 \qquad 4$$

Determination of Fixed Carbon

The fixed carbon in percentage was calculated by difference (Jain and Jain, 2001).

$$\text{Fixed carbon } (\%) = 100 - \text{percentage of (moisture content } + \text{volatile matter} + \text{ash)} \qquad 5$$

Ultimate Analysis of Marking Nut Shell (MNS)

Carbon, hydrogen, nitrogen and oxygen content of marking nut shell were found out under the ultimate analysis. The ultimate analysis is helpful in calculating heat balances in any process in which shell is used as fuel. Using the values of proximate analysis, ultimate analysis of MNS was calculated by using the following formulae.

Determination of Carbon Content

Carbon content of the sample was calculated on the basis of following formula (Sanger et al, 2011),

$$\text{Carbon content } (\%) = 0.97\text{FC} + 0.7\ (\text{VM} - 0.1\text{A}) - \text{M}(0.6 - 0.01\text{M}) \quad 6$$

Determination of Hydrogen Content

Hydrogen content of the sample was calculated on the basis of following formula (Sanger et al, 2011),

$$\text{Hydrogen content } (\%) = 0.036\text{FC} + 0.086(\text{VM} - 0.01\text{A}) - 0.0035\text{M}^2(10.02\text{M}) \quad 7$$

Determination of Nitrogen Content

Nitrogen content of the sample was calculated on the basis of following formula (Sanger et al, 2011),

$$\text{Nitrogen content } (\%) = 2.10 - 0.020\text{VM} \quad 8$$

Determination of Oxygen Content

Oxygen content of the sample was calculated theoretically by difference on the basis of the following formula (Sanger et al, 2011),

$$\text{Oxygen content } (\%) = 100 - \text{percentageof } (\text{C} + \text{H} + \text{N} + \text{Ash}) \quad 9$$

Where,

FC = fixed carbon, %

A = ash, %

VM = volatile matter, %

M = moisture, %

RESULTS AND DISCUSSIONS

Marking nut shell is waste product obtained during deshelling of marking nut kernels and is utilized as a substitute to wood fuel. The oil content in marking nut shell was found in the range of 21.40 to 21.88%. Similar results were observed for jatropha curcas (Joshi et al 2011, Umaru and Aberuagba, 2012, Emil et al 2009), date seeds (Boukouada and Yousfi, 2009), for castor seed (Mgudu et al 2012), for cashew nut (Bello et al 2013, Akbar et al 2009). The ultimate and proximate analysis of marking nut shell were determined and presented.

Proximate Analysis of Marking Nut Shell (MNS)

Proximate analysis of marking nut shell MNS, marking nut deoiled shell and marking nut traditionally deoiled shell for determination of moisture content, volatile matter, ash content and fixed carbon was carried out. The results of proximate analysis are shown in figure 4.1 to figure 4.4 respectively.

It was observed that moisture content of the marking nut shell was 2.484 % and for marking nut deoiled shell and traditionally deoiled shell. It was found to be zero percent due to heating (figure 4.1).

The moisture in shell evaporates during the burning of shell and it takes some amount of liberated heat in the form of latent heat of evaporation, therefore, moisture lowers. Moreover, it quenches the fire in the furnace. Hence, lesser the moisture content, better the quality of shell as a fuel. However, presence of moisture, upto 10%, produces a more uniform fuel-bed and less of “fly-ash”. (Jain and Jain, 2001)

The volatile matter observed as 85.093%, 54.521% and 81.737% for marking nut shell, marking nut deoiled shell and traditionally deoiled shell respectively (figure 4.2). The volatile matter present in marking nut shell was found to be more in percentage than traditionally deoiled shell and deoiled shell.

The ash content in the MNS, marking nut deoiled shell and marking nut traditionally deoiled sample was found to be in the range of 3.704 to 4.373%, 32.42 to 34.76% and 10.68 to 11.32%, respectively shown in figure 4.3. The average value for ash content in the MNS, marking nut deoiled shell and marking nut traditionally deoiled sample was found 4.35%, 34.82% and 10.89%, respectively. The ash content in marking nut deoiled shell increases due to removal of moisture content and volatile matter. The ash present in marking nut shell (MNS) is less than traditionally deoiled shell and then deoiled shell.

The fixed carbon percentage in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be in the range of 7.477 to 8.411%, 9.709 to 11.54% and 6.796 to 7.767% respectively (Figure 4.4). The fixed carbon percentage in the MNS, marking nut deoiled shell and marking nut traditionally deoiled shell sample was found as 8.074%, 10.64% and 7.37%, respectively. From the figure 4.4, it was observed that marking nut deoiled shell has high fixed carbon than marking nut shell sample and marking nut traditionally deoiled shell sample.

Similar results were reported for cashew nut shell (Sanger et al 2011), almond seed (Akpabio, 2012), soya bean (Francis, 2012) and cashew nut shell (Ganesh and Das, 2003).

4.2 Ultimate Analysis of Marking Nut Shell (MNS)

The ultimate analysis of MNS, marking nut deoiled shell and marking nut traditionally deoiled shell was carried out in order to determine its carbon, hydrogen, nitrogen and oxygen percentage. The results of ultimate analysis of MNS, marking nut deoiled shell and marking nut traditionally deoiled shell are shown graphically in figure 4.5 to 4.8.

The carbon content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be in the range of 65.028 to 65.991%, 44.214 to 48.214% and 63.321 to 63.874% respectively (figure 4.5). The average value of carbon content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 65.602%, 46.049% and 63.602%, respectively.

The hydrogen content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be in the range of 7.47 to 7.612%, 4.624 to 5.035% and 7.152 to 7.25% respectively (figure 4.6). The average value of hydrogen content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 7.55%, 4.772% and 7.201%, respectively.

Greater the percentage of carbon and hydrogen, better the fuel in quality and calorific value. Hence, hydrogen is mostly associated with the volatile matter and hence it affects the use to which the fuel id put. Hence, marking nut traditional deoiled shell and marking nut shell has greater percentage of carbon and hydrogen than deoiled shell.

The nitrogen content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be in the range of 0.38 to 0.418%, 0.954 to 1.042% and 0.45 to 0.477% respectively (figure 4.7). The average value of nitrogen content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 0.398%, 1.01% and 0.465%, respectively.

Nitrogen has no calorific value and hence, its presence in fuel is undesirable. Thus, good quality fuel should have

very little nitrogen content. Hence, marking nut shell and marking nut traditionally deoiled shell has less percentage of nitrogen than deoiled shell.

Similarly, from the figure 4.8, the oxygen content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be in the range of 21.344 to 22.544%, 13.002 to 13.758% and 17.729 to 18.009%, respectively. The oxygen content in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 21.618%, 13.3325 and 17.838%, respectively.

Oxygen content decreases the calorific value of coal. High oxygen content are characterized by high inherent moisture, low calorific value and low coking power. Moreover, oxygen is in combined form with hydrogen in fuel and thus, hydrogen available for combustion is lesser than actual one. An increase in 1% oxygen content decreases the calorific value by about 1.7% and hence the oxygen is undesirable. Thus, a good quality coal should have low percentage of oxygen (Jain and Jain 2001).

CONCLUSIONS

It was observed that maximum fixed carbon percentage found in cashew nut shell char as 10.64 per cent. Moisture content of the MNS was 2.484 % and for MN deoiled shell and traditionally deoiled shell was found to be zero percent. The volatile matter present in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 85.093%, 54.521% and 81.737% respectively. Ash content in the MNS, marking nut deoiled shell and marking nut traditional deoiled sample was found to be 4.35%, 34.82% and 10.89% respectively. The fixed carbon percentage in the MNS, marking nut deoiled shell and marking nut traditional deoiled shell sample was found to be 8.074%, 10.64% and 7.37% respectively.

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APPENDICES

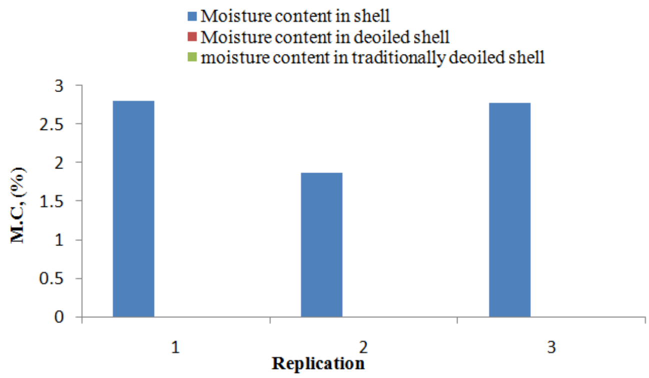

Figure 4.1: Percent Moisture Content in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell

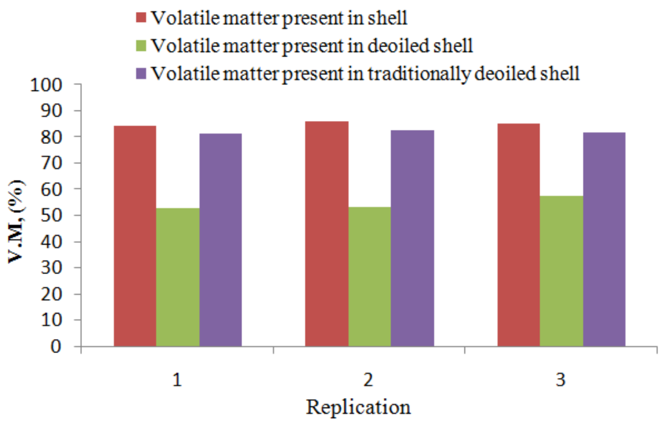

Figure 4.2: Percent Volatile Matter Present in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell

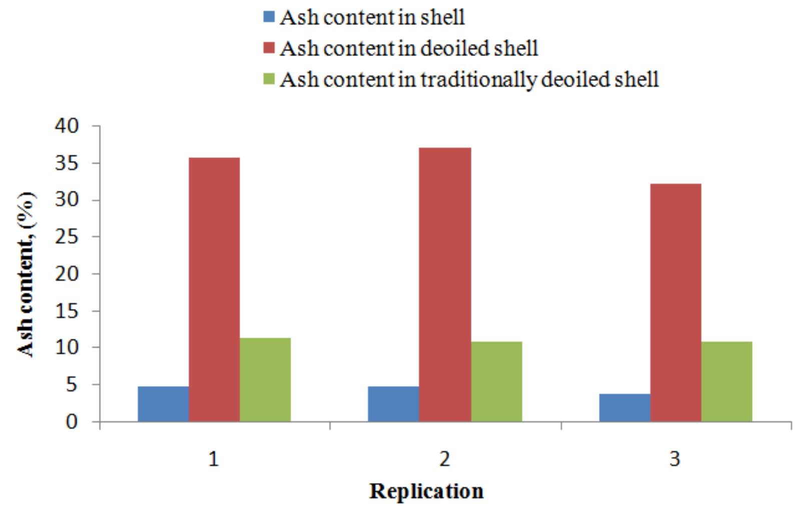

Figure 4.3: Percent Ash Content in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell

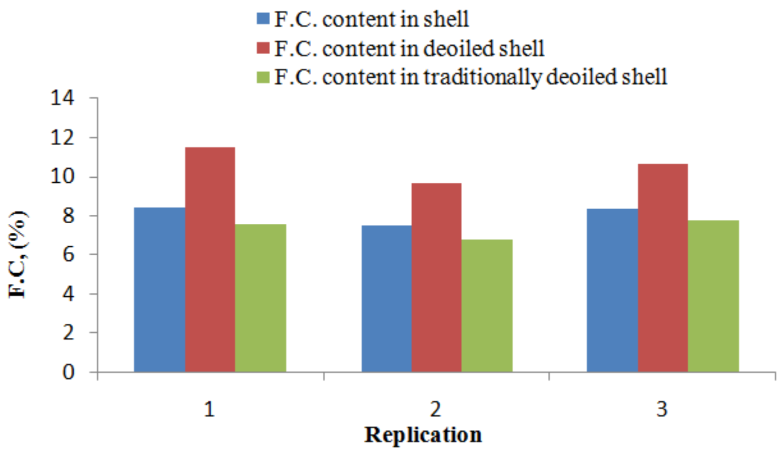

Figure 4.4: Percent Fixed Carbon Content in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell

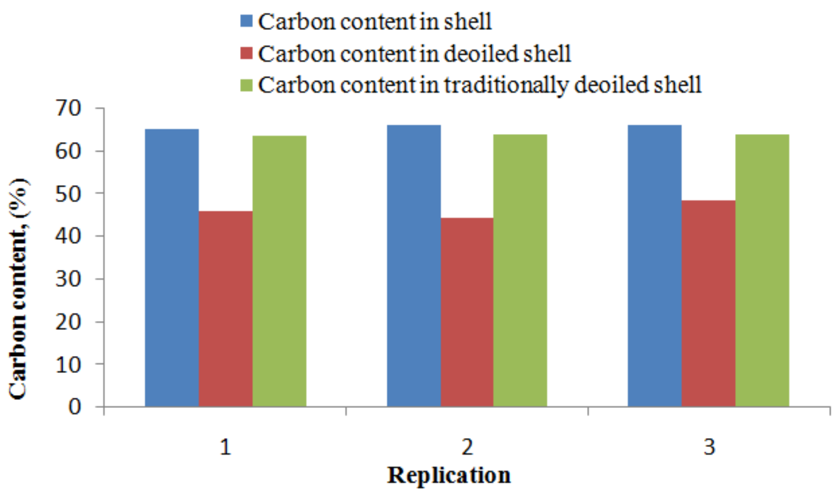

Figure 4.5: Percent Carbon Content in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell

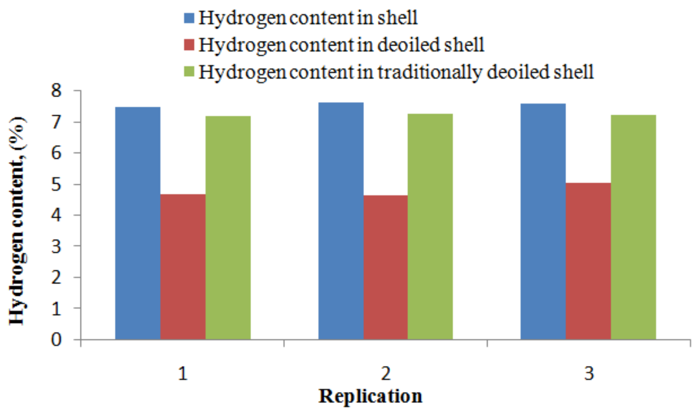

Figure 4.6: Percent Hydrogen Content in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell

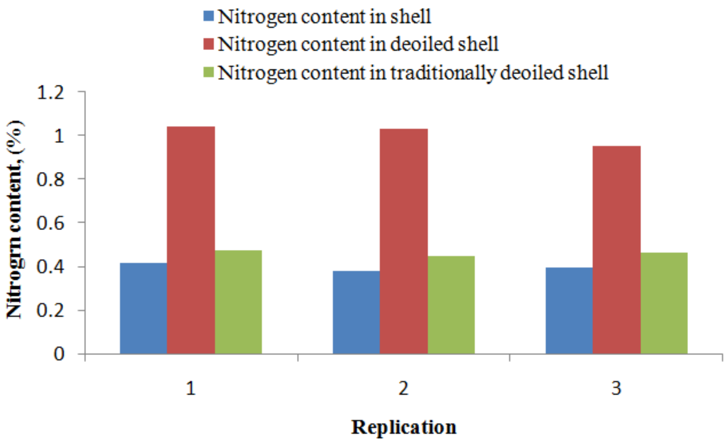

Figure 4.7: Percent Nitrogen Content in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell

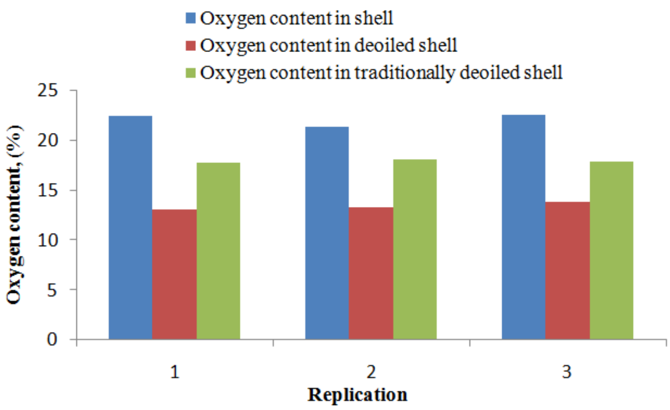

Figure 4.8: Percent Oxygen Content in Marking Nut Shell, Deoiled Shell and Traditionally Deoiled Shell